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Studies of the Auger spectrum from the (100) surface of GaAs using positron annihilation induced Auger electron spectroscopy

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Abstract

Measurements of the first high-resolution positron annihilation induced Auger spectrum from GaAs(100) are presented. The spectrum displays six As and three Ga Auger peaks below 110 eV, including a strong As $M_{4,5}VV$ peak at 28 eV and a less intense Ga $M_{2,3}M_{4,5}M_{4,5}$ peak at 53 eV. The Auger peak intensities are used to obtain experimental annihilation probabilities for relevant core-level electrons. Experimental results are compared with first-principles calculations of positron surface states and annihilation characteristics of surface trapped positrons. © 2000 Elsevier Science Ltd. All rights reserved.

1. Introduction

Recently semiconductor surfaces have become the subject of experimental studies using positron-annihilation-induced Auger-electron spectroscopy (PAES) (Weiss, 1992; Fazleev et al., 1997). PAES makes use of low energy (10 eV in this case) positrons to create the core ionizations necessary for Auger spectroscopy by annihilation of core electrons. The PAES core ionization mechanism gives the technique several advantages over conventional Electron induced Auger Electron Spectroscopy (EAES) which include: (1) the elimination of the large secondary electron background present in the Auger peak range in the EAES spectra due to the high energy (>1 keV) incident electron beam required for collisional ionization. In PAES, the low energy positron beam keeps the secondary electron background below the beam energy by energy conservation. (2) PAES has greater surface selectivity that permits PAES to be used to characterize the elemental content of the topmost atomic layer of atoms. The PAES mechanism can be outlined as follows: (a) positrons implanted at low energy quickly lose energy, diffuse to and get trapped in an "image-correlation" potential well at the surface (Schultz and Lynn, 1988); (b) most positrons will annihilate with valence electrons, but a few percent will annihilate with core electrons leaving the atoms in excited states; (c) the atoms relax via the emission of Auger electrons (Weiss, 1992). Since PAES intensities are sensitive to the spatial distribution of the positron wave function on the surfaces of interest, the method has been already used to study the nature and localization of positron surface states at metal and semiconductor surfaces.

This paper reports the first high resolution PAES spectrum from a compound semiconductor,

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